SELECTED REPRODUCTIVE OUTCOMES AMONG RESIDENTS OF SIMCOE COUNTY, ONTARIO.

1975-1982

Disease Control and Epidemiology Service
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SUMMARY

A review of data reflecting reproductive health was undertaken to examine the possibility of potential adverse health effects of aerial pesticide spraying in the vicinity of Tiny Township Simcoe county, Ontario, a community of 7,170 population in 1981.

Measures of reproductive outcomes can serve as sensitive indicators of environmental influences upon health that are observable within a relatively short time span. Data on congenital anomalies detected during the first year of life for the years 1975-1982, stillbirths 1970-1982, and spontaneous abortions (miscarriages) 1975-1983 were examined. These indicators of reproductive experience among Simcoe county residents were compared to those of the province as a whole using standardized reproductive ratios (similar to standardized mortality ratios).

The number of stillbirths in Simcoe county was within expected limits, with the exception of the single year 1977, when a higher than expected number of stillbirths occurred. An expected rate of occurrence of congenital anomalies was experienced in the county, except for an increased incidence of hydrocephaly in the combined time period 1975-1979 and an elevated incidence of anencephaly (total number = 4) among births to Simcoe county residents in 1982. None of the four cases of anencephaly occurred among residents of Tiny Township. Spontaneous abortions among residents of the county remained well within expected limits for the years studied.

The following table provides an overview of the observed and expected numbers of cases of stillbirths, hydrocephaly and anencephaly in Simcoe county between 1975 and 1982.

	Stillbirths		Hydrocephaly		Anencephaly	
	Observed # Cases	Expected # Cases	Observed # Cases	Expected # Cases	Observed # Cases	Expected # Cases
1975	42	31.4	(Hydrocephaly and anencephaly are			
1976	28	32.2	for 1975-1979 combined)			
1977	42	28.2*	19	11.8*	13	11.3
1978	28	26.2				
1979	29	24.6				
1980	22	24.6	1	2.0	4	1.9
1981	19	22.6	1	1.2	0	1.4
1982	29	24.3	0	1.4	4	1.4*

* = Statistically significant

The sporadic excesses of anencephaly, hydrocephaly and stillbirths in Simcoe county determined by this review were not sustained over time. These events appear to have been isolated instances, without evidence of clustering with respect to geographic region of the county, making an environmental etiology unlikely. In this analysis, sixty different rates of reproductive events were determined for Simcoe county. It would be expected on a statistical basis that as many as three observed rates might differ significantly from expected rates (the number elevated in this study) on the basis of chance alone. It is most probable that the few significant elevations in events occurred by chance alone and are likely related to individual maternal factors of health/lifestyle.

SELECTED REPRODUCTIVE OUTCOMES AMONG RESIDENTS OF SIMCOE COUNTY, ONTARIO 1975-1982

INTRODUCTION

This report was prepared in response to concerns of residents of Tiny Township, Simcoe county, that aerial spraying of pesticides was adversely affecting the health of the population.

A report entitled "Cancer Mortality in Tiny Township, Ontario 1971-1981" has been compiled by the Federal Government and analyzes cancer mortality data.[1] The present report investigates reproductive outcome data, specifically congenital anomalies, stillbirths and spontaneous abortions. Unfortunately, these data are not available for geographical areas as small as Tiny Township; therefore analysis of Simcoe county data was performed and compared with provincial data.

METHODOLOGY

Congenital anomalies data were compiled using the Surveillance of Congenital Anomalies System[2] for the period 1975-1979 and the Hospital Medical Record Institute (HMRI)[3] data for the years 1980-1982. Ten anomalies commonly associated with chemical exposure in utero were chosen for study: anencephaly, spina bifida, hydrocephaly, cleft palate/lip, T-E fistula/esophageal atresia and stenosis, rectal/anal atresia and stenosis, hypospadias and epispadias, congenital dislocation of the hip, reduction deformation of limbs and Down syndrome. All data were reported for first year of life experience. For each time period the rates per 10,000 total births (live births plus stillbirths) were calculated, as well as a Standardized Congenital Anomalies Ratio (SCAR). SCARs are ratios of observed numbers of congenital anomalies in Simcoe county to the expected values based on provincial rates. The SCAR is, thus, an indicator of how the county's actual experience compares to an expected (theoretical) experience if provincial rates are applied. A Poisson probability test was applied to these data to determine if Simcoe county's rates were statistically significantly higher than those expected.

Stillbirth data for 1970-1982 were obtained from the Ontario Registrar General's publications of Vital Statistics[4]. Rates were calculated per 1000 live births, and a Standardized Stillbirth Ratio (SSR) was generated and tested for significance by the same method as described previously.

Spontaneous abortion data were retrieved through the Hospital Discharge Form[3] for the years prior to 1979/80, and from HMRI sources[3] following that period. At that time, the reporting system changed from calendar year to fiscal year. The first fiscal reporting year still contained only twelve months, as there was no reporting between January and April 1979. Rates were again calculated per 1000 live births, with a significance test being applied to the Standardized Spontaneous Abortion Ratio (SSAR). It should be noted that these data were limited by the fact that women who experience a spontaneous abortion outside of the hospital are not captured.

Confidence limits were calculated for each set of data. The limits were set at 95% and were constructed around each data point. These confidence intervals represent the upper and lower points between which Simcoe county rates are expected to remain 95% of the time. Any Simcoe rate exceeding the upper limit is considered significantly higher than the expected value based on provincial data. Statistically, a Simcoe county rate may be expected to fall outside of the confidence limit purely by chance one time in twenty.

RESULTS

Congenital anomalies rates and Standardized Congenital Anomaly Ratios (SCAR) for Simcoe county and the Province of Ontario for the years 1975-1982, are shown in Table 1. Data collection was grouped for the period 1975-1979 due to the low number of cases. Of the ten anomalies analyzed, only hydrocephaly during the 1975-1979 period, and anencephaly in 1982 showed statistical significance at the 95% confidence level (Figure 1). In 1975-1979 Simcoe county experienced 19 cases of hydrocephaly, while 11.7 cases were expected. In 1982, Simcoe county experienced four cases of anencephaly, and 1.4 cases were expected.

Stillbirth data with Standardized Stillbirth Ratios are shown in Table 2, and displayed graphically in Figure 2. Significance testing at the 95% level revealed a statistically significant elevation of stillbirths in Simcoe county in 1977. During that year, eleven stillbirths were expected; the county experienced forty-two stillbirths. There has been a steady downward trend over time in stillbirth rates for both the province and Simcoe county.

Spontaneous abortion data with Standardized Spontaneous Abortion Ratios are displayed in Table 3 and in Figure 3. Only data for the first six months in 1975 were available for analysis due to incomplete diagnostic coding. Simcoe county spontaneous abortion rates do not differ statistically from provincial rates.

Table 4 shows the maternal age distribution in Simcoe county for the years 1975-1982. During that time, there was a decrease in the percent of mothers below the age of twenty from 12.2 to 8.3%, while women aged 30 and over made up a larger proportion of all births, 15.8% in 1975 versus 21.8% by 1982. However, on a year-to-year basis, the relative maternal age distribution has remained fairly similar.

DISCUSSION

The data indicate that Simcoe county experienced expected rates of congenital anomalies from 1975 to 1982 except for hydrocephaly in the combined period 1975 to 1979 and anencephaly in 1982. Stillbirth rates were not significantly elevated except during 1977. County rates are expected to be more unstable than provincial rates because they are based on infrequent events in small populations. One rate in twenty may be outside the 95% confidence limit of the provincial rate on a purely statistical basis.

A review of the literature revealed that rates of anencephaly and spina bifida have been decreasing in several countries (Britain, Australia, U.S.A., Netherlands).[6] This trend appears to be independent of screening and intervention. British Columbia experienced a fall in incidence of anencephaly in stillborns over the 10-year period 1971-1980.[7] The increased use of ultrasonography and subsequent termination of pregnancy was offered as a possible explanation. In Ontario, rates of spina bifida have shown a steady decline, while anencephaly rates have remained fairly constant, ranging from 5.1 to 7.4 per 10,000 total births. There was no time or place cluster evident among the four 1982 Simcoe county anencephaly cases. These cases differed with respect to season and geographical location. None of these cases occurred among Tiny Township residents.

In British Columbia, risk of anencephaly has not been associated with locality population size, mean income, proportion of women employed or drinking water concentration of 14 elements (calcium, magnesium, copper, lithium, zinc, nickel, lead, selenium, mercury, chromium, silver, cobalt, cadmium, molybdenum).[8] There is considerable evidence in the literature from which to infer that neural tube defects (which include anencephaly) are associated with multiple factors.

Neural tube defects occurring in combination with other anomalies have been recently demonstrated to be associated with ground water ingestion as compared to rain water ingestion, with the difference being associated with nitrate concentration above 15 ppm.[10]

Anencephaly appears to be related to several different etiologic factors: sex (females greater than males), color (whites greater than blacks), presence of a previous infant in the family with the same defect which may indicate a genetic etiology, and decreasing rates over time which may be related to prenatal environment.[9]

Agricultural chemical use has been reported as a risk factor for cleft lip or palate.[11] However, neural tube defects do not appear to be similarly associated.[12] Simcoe rates for cleft lip and palate have fallen from 1975-1982 and have not been significantly elevated above provincial rates.

Clustering of malformations, especially spina bifida, has been demonstrated in other studies. This phenomenon appears to occur independently of herbicide use.[13]

Stillbirth rates for Ontario and Simcoe county have shown a downward trend over time. The etiology of stillbirths is complex and may be related to such factors as maternal health status and availability of health care. The observed excess of stillbirths in Simcoe county in 1977 cannot be explained on the basis of agricultural chemical use. Maternal and lifestyle factors would be more likely to affect stillbirth rates than chemical exposures, unless these exposures are acute and high dose.

Spontaneous abortion rates for the county have remained well within expected limits for the years studied. Other studies have shown spontaneous abortion rates to be stable for many years.[14] Simcoe county follows this secular trend, as does Ontario.

It is not possible from this review to determine the specific etiology of the sporadic excess of anencephaly and hydrocephaly in Simcoe County. Gradual shifts in maternal age distribution of births in Simcoe county would not be likely to account for the few instances of elevations in adverse outcomes. In addition, there was no time or place clustering of the 4 cases of anencephaly in 1982. It is most probable that the few statistically significant elevations in rates detected by this analysis occurred by chance alone. In this analysis, sixty different rates of reproductive events were determined for Simcoe county; it would be expected that as many as three rates could be significantly different from expected rates (as was shown) on the basis of chance alone.

Addendum:

The number of cases of hydrocephaly for the years 1975-1979 were 19 for Simcoe County which is in excess of the expected number, 11.8 cases. Seven of these cases occurred in 1978-1979, the only years for which township-of-residence data were available. None of the 1978-1979 cases of hydrocephaly was in Tiny Township.

TABLE 1

NUMBER OF CONGENITAL ANOMALIES AND CONGENITAL ANOMALIES RATES PER 10,000 BIRTHS WITHIN THE FIRST YEAR OF LIFE, WITH STANDARDIZED CONGENITAL ANOMALIES RATIOS (SCAR) FOR THE PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975-1982.

1975-1979

	ONTARIO		SIMCOE COUNTY			
	Observed		Observed		Expected	
Anomaly	# Cases	Rate	# Cases	Rate	# Cases	SCAR
Anencephaly	431	7.0	13	8.0	11.3	1.1
Spina Bifida	583	9.4	15	9.2	15.3	1.0
Hydrocephaly	450	7.3	19	11.7	11.8	1.6*
Cleft palate/lip	844	13.6	29	17.8	22.1	1.3
T-E Fistula/Esophageal Atresia and Stenosis	102	1.6	4	2.4	2.7	1.5
Rectal/Anal Atresia and Stenosis	208	3.4	4	2.4	5.4	0.7
Hypospadias and Epispadias	743	12.0	10	6.1	19.4	0.5
Congenital Dislocation of the Hip	719	11.6	14	8.6	18.8	0.7
Reduction Deformation of Limbs	206	3.3	5	3.0	5.4	0.9
Down Syndrome	415	6.7	11	6.7	10.9	1.0

TOTAL BIRTHS: ONTARIO = 619,205; SIMCOE COUNTY = 16,212
RATES EXPRESSED PER 10,000 BIRTHS (LIVE BIRTHS AND STILLBIRTHS)
* $p < .05$

1980

	ONTARIO		SIMCOE COUNTY			
	Observed		Observed		Expected	
Anomaly	# Cases	Rate	# Cases	Rate	# Cases	SCAR
Anencephaly	73	5.9	4	12.7	1.9	2.1
Spina Bifida	110	8.7	3	9.5	2.8	1.1
Hydrocephaly	77	5.6	1	3.2	2.0	0.5
Cleft palate/lip	207	16.5	8	25.4	5.4	1.5
T-E Fistula/Esophageal Atresia and Stenosis	25	2.0	1	3.2	0.6	1.6
Rectal/Anal Atresia and Stenosis	13	0.9	1	3.2	0.3	3.3
Hypospadias and Epispadias	347	27.7	8	25.4	9.0	0.9
Congenital Dislocation of the Hip	420	31.5	3	9.5	10.9	0.3
Reduction Deformation of Limbs	51	3.9	2	6.3	1.3	1.5
Down Syndrome	132	9.5	3	9.5	3.4	0.9

TOTAL BIRTHS: ONTARIO = 124,268; SIMCOE COUNTY = 3,214
RATES EXPRESSED PER 10,000 BIRTHS (LIVE BIRTHS AND STILLBIRTHS)

TABLE 1 - continued

1981

Anomaly	ONTARIO Observed # Cases	ONTARIO Observed Rate	SIMCOE COUNTY Observed # Cases	SIMCOE COUNTY Observed Rate	SIMCOE COUNTY Expected # Cases	SCAR
Anencephaly	53	4.4	0	0.0	1.4	0.0
Spina Bifida	71	5.9	1	3.2	1.8	0.6
Hydrocephaly	48	3.9	1	3.2	1.2	0.8
Cleft palate/lip	187	15.5	9	28.3	4.8	1.9
T-E Fistula/Esophageal Atresia and Stenosis	28	2.3	1	3.2	0.7	1.4
Rectal/Anal Atresia and Stenosis	18	1.5	0	0.0	0.5	0.0
Hypospadias and Epispadias	293	24.2	8	25.3	7.8	1.0
Congenital Dislocation of the Hip	393	32.5	10	31.6	10.2	1.0
Reduction Deformation of Limbs	33	2.7	0	0.0	0.8	0.0
Down Syndrome	96	7.9	2	6.3	2.5	0.8

TOTAL BIRTHS: ONTARIO = 123,057; SIMCOE COUNTY = 3,181
RATES EXPRESSED PER 10,000 BIRTHS

1982

Anomaly	ONTARIO Observed # Cases	ONTARIO Observed Rate	SIMCOE COUNTY Observed # Cases	SIMCOE COUNTY Observed Rate	SIMCOE COUNTY Expected # Cases	SCAR
Anencephaly	54	4.5	4	13.4	1.4	2.8*
Spina Bifida	83	7.0	2	6.7	2.1	0.9
Hydrocephaly	56	4.7	0	0.0	1.4	0.0
Cleft palate/lip	137	11.5	1	3.4	3.5	0.3
T-E Fistula/Esophageal Atresia and Stenosis	18	1.5	0	0.0	0.5	0.0
Rectal/Anal Atresia and Stenosis	18	1.5	0	0.0	0.5	0.0
Hypospadias and Epispadias	339	28.6	13	43.7	8.7	1.5
Congenital Dislocation of the Hip	418	35.2	9	30.2	10.8	0.8
Reduction Deformation of Limbs	38	3.2	2	6.7	1.0	2.0
Down Syndrome	120	10.1	5	16.8	3.1	1.6

TOTAL BIRTHS: ONTARIO = 125,455; SIMCOE COUNTY = 3,235
RATES EXPRESSED PER 10,000 BIRTHS (LIVE BIRTHS AND STILLBIRTHS)
* $p < 0.05$

TABLE 2

NUMBER OF STILLBIRTHS AND STILLBIRTH RATES PER 1,000 LIVE BIRTHS WITH STANDARDIZED STILLBIRTH RATIOS (SSR). PROVINCE OF ONTARIO AND SIMCOE COUNTY 1970-1982.

	ONTARIO			SIMCOE COUNTY				
Year	# Still-births	# Live Births	Observed Rate	# Still-births	# Live Births	Observed Rate	Expected # Stillbirths	SSR
1970	1,679	134,724	12.5	43	2,801	15.3	34.9	1.2
1971	1,576	130,395	12.1	27	2,842	9.5	34.3	0.8
1972	1,534	125,060	12.3	37	2,980	12.4	36.6	1.0
1973	1,362	123,776	11.0	21	2,919	7.2	32.1	0.6
1974	1,335	124,229	10.7	34	3,236	10.5	34.8	1.0
1975	1,205	125,775	9.6	42	3,276	12.8	31.4	1.3
1976	1,203	122,700	9.8	28	3,290	8.5	32.2	0.9
1977	1,086	122,757	8.8	42	3,184	13.2	28.2	1.5*
1978	971	120,964	8.0	28	3,168	8.8	26.2	1.1
1979	958	121,655	7.9	29	3,127	9.3	24.6	1.2
1980	952	123,316	7.7	22	3,192	6.9	24.6	0.9
1981	874	122,183	7.1	19	3,162	6.0	22.6	0.8
1982	943	124,512	7.6	29	3,206	9.0	24.3	1.2

RATES EXPRESSED PER 1,000 LIVE BIRTHS

* $p < 0.05$

TABLE 3

NUMBER OF SPONTANEOUS ABORTIONS AND SPONTANEOUS ABORTION RATES PER 1,000 LIVE BIRTHS WITH STANDARDIZED SPONTANEOUS ABORTION RATIOS (SSAR). PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975 - 1983.

	ONTARIO			SIMCOE COUNTY				
	# Spontaneous Abortions	# Live Births	Observed Rate	# Spontaneous Abortions	# Live Births	Observed Rate	Expected # Spontaneous Abortions	SSAR
1975 6 months)	5,979	62,887	95.1	143	1,638	87.3	154.6	0.9
1976	11,777	122,700	95.9	280	3,290	85.1	312.6	0.9
1977	10,953	122,757	89.2	278	3,184	87.3	283.6	1.0
1978	10,903	120,964	90.1	260	3,168	82.1	283.4	0.9
1979/80	11,758	121,655	96.6	322	3,127	102.9	304.0	1.0
1980/81	11,528	123,316	93.5	306	3,192	95.9	299.0	1.1
1981/82	11,487	122,183	94.0	277	3,162	87.6	295.5	0.9
1982/83	11,590	124,512	93.1	301	3,206	93.9	298.6	1.0

RATES EXPRESSED PER 1,000 LIVE BIRTHS
* $p < .05$

TABLE 4

MATERNAL AGE DISTRIBUTION OF BIRTHS IN
SIMCOE COUNTY 1975-1982

Age	1975	1976	1977	1978	1979	1980	1981	1982
< 20	399	388	375	338	298	338	265	268
(%)	(12.2)	(11.8)	(11.8)	(10.7)	(9.5)	(10.6)	(8.4)	(8.3)
20-24	1113	1127	1041	1058	1020	979	1012	1008
(%)	(33.9)	(34.2)	(32.7)	(33.4)	(32.6)	(30.7)	(32.0)	(31.4)
25-29	1245	1197	1175	1148	1178	1232	1205	1231
(%)	(38.0)	(36.4)	(36.9)	(36.2)	(37.7)	(38.6)	(38.1)	(38.4)
30-34	404	449	505	505	514	536	545	538
(%)	(12.3)	(13.6)	(15.9)	(15.9)	(16.4)	(16.8)	(17.2)	(16.8)
35 +	115	129	88	119	115	105	133	161
(%)	(3.5)	(3.9)	(2.8)	(3.7)	(3.7)	(3.3)	(4.2)	(5.0)
Unknown	0	0	0	0	2	2	2	0
(%)	(0.0)	(0.0)	(0.0)	(0.0)	(0.06)	(0.06)	(0.06)	(0.0)
TOTAL	3276	3290	3184	3168	3127	3192	3162	3206

FIGURE 1

CONGENITAL ANOMALIES RATES PER 10,000 BIRTHS FOR THE PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975-1982

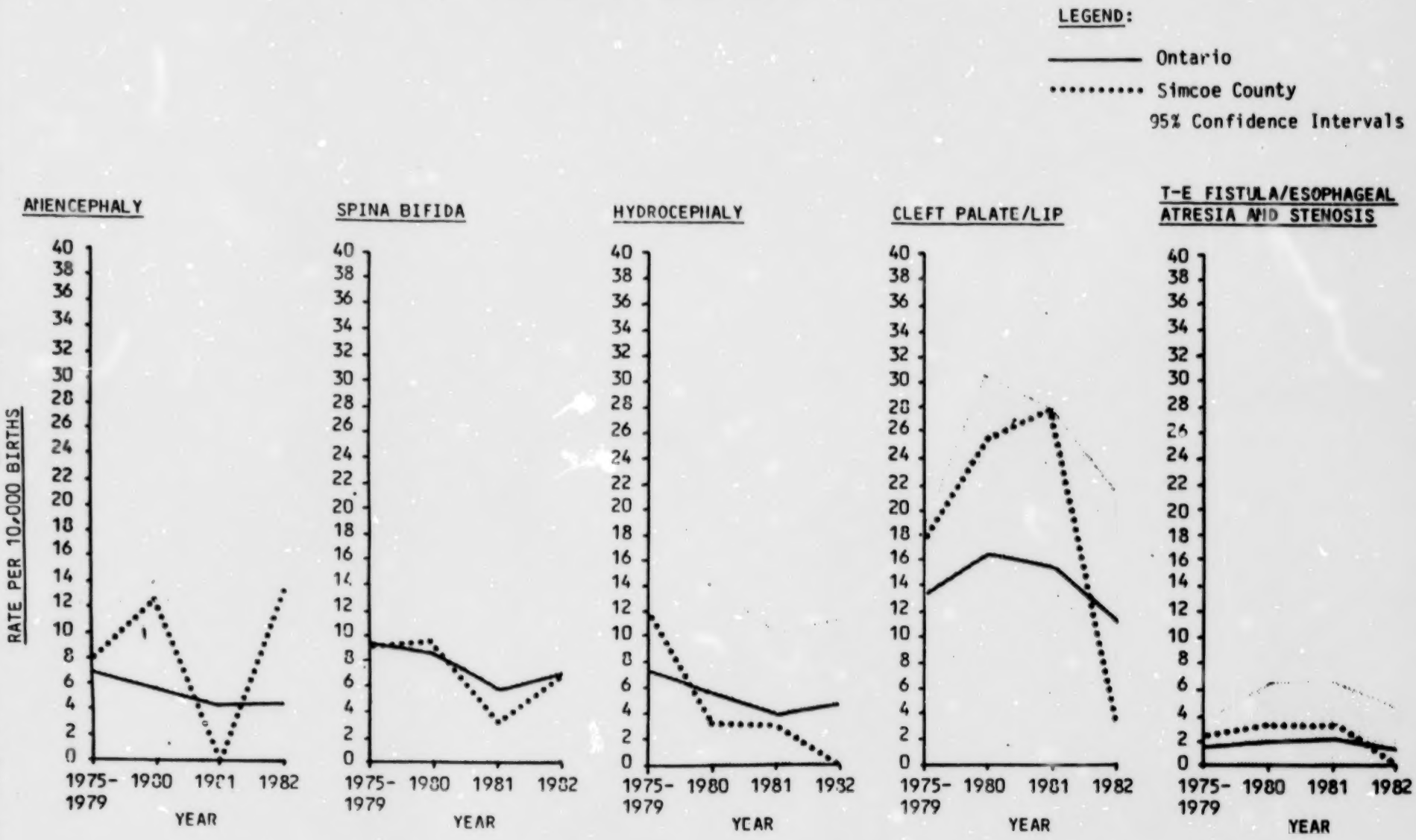


FIGURE 1 Cont'd.

CONGENITAL ANOMALIES RATES PER 10,000 BIRTHS FOR THE PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975-1982

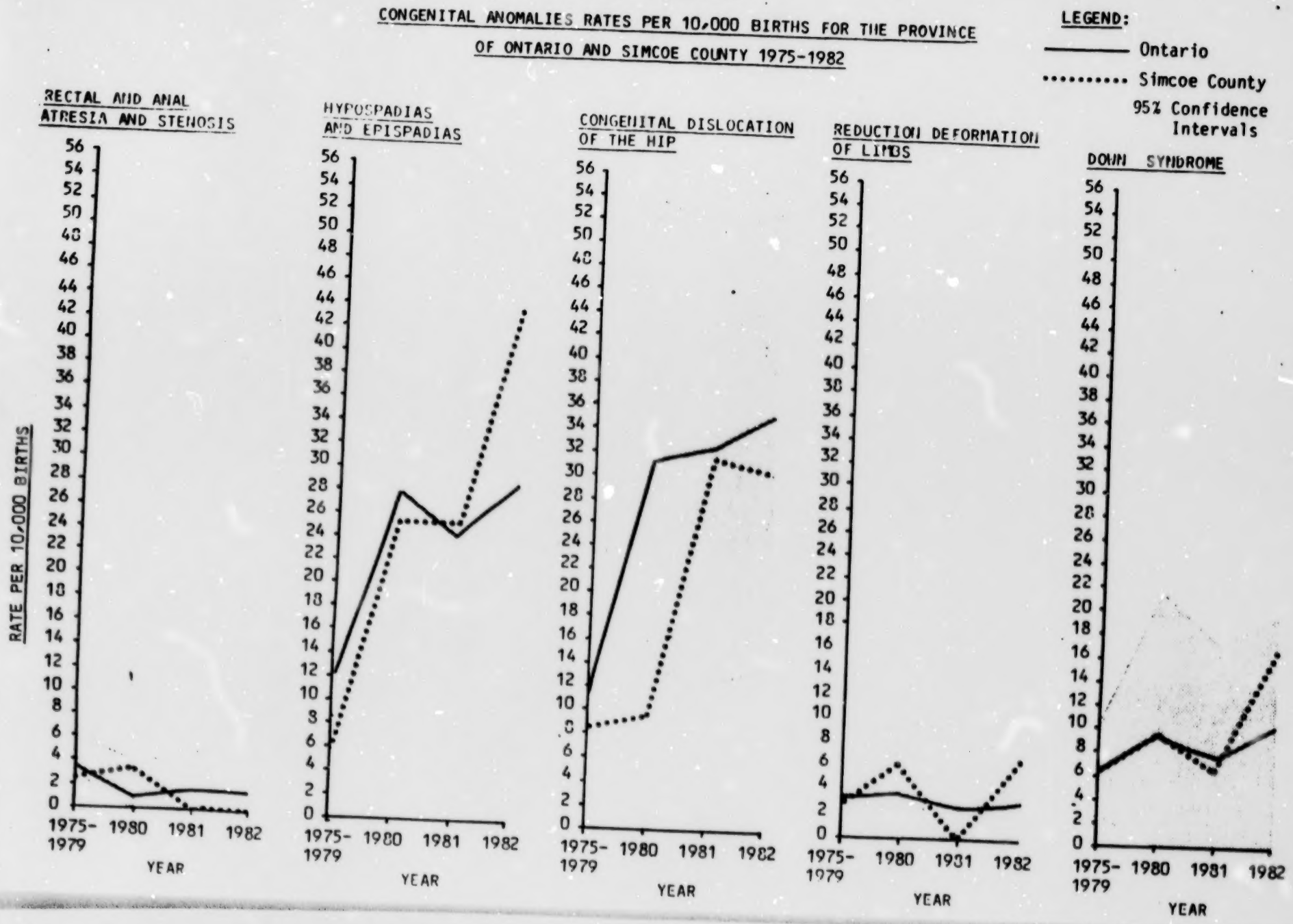

LEGEND:
Ontario
Simcoe County
95% Confidence Intervals
RECTAL AND ANAL ATRESIA AND STENOSIS
HYPOSPADIAS AND EPISPADIAS
CONGENITAL DISLOCATION OF THE HIP
REDUCTION DEFORMATION OF LIMBS
DOWN SYNDROME
RATE PER 10,000 BIRTHS
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56
1975-1979
1980
1981
1982
YEAR

FIGURE 2

STILLBIRTH RATES PER 1,000 LIVE BIRTHS FOR THE PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975-1982

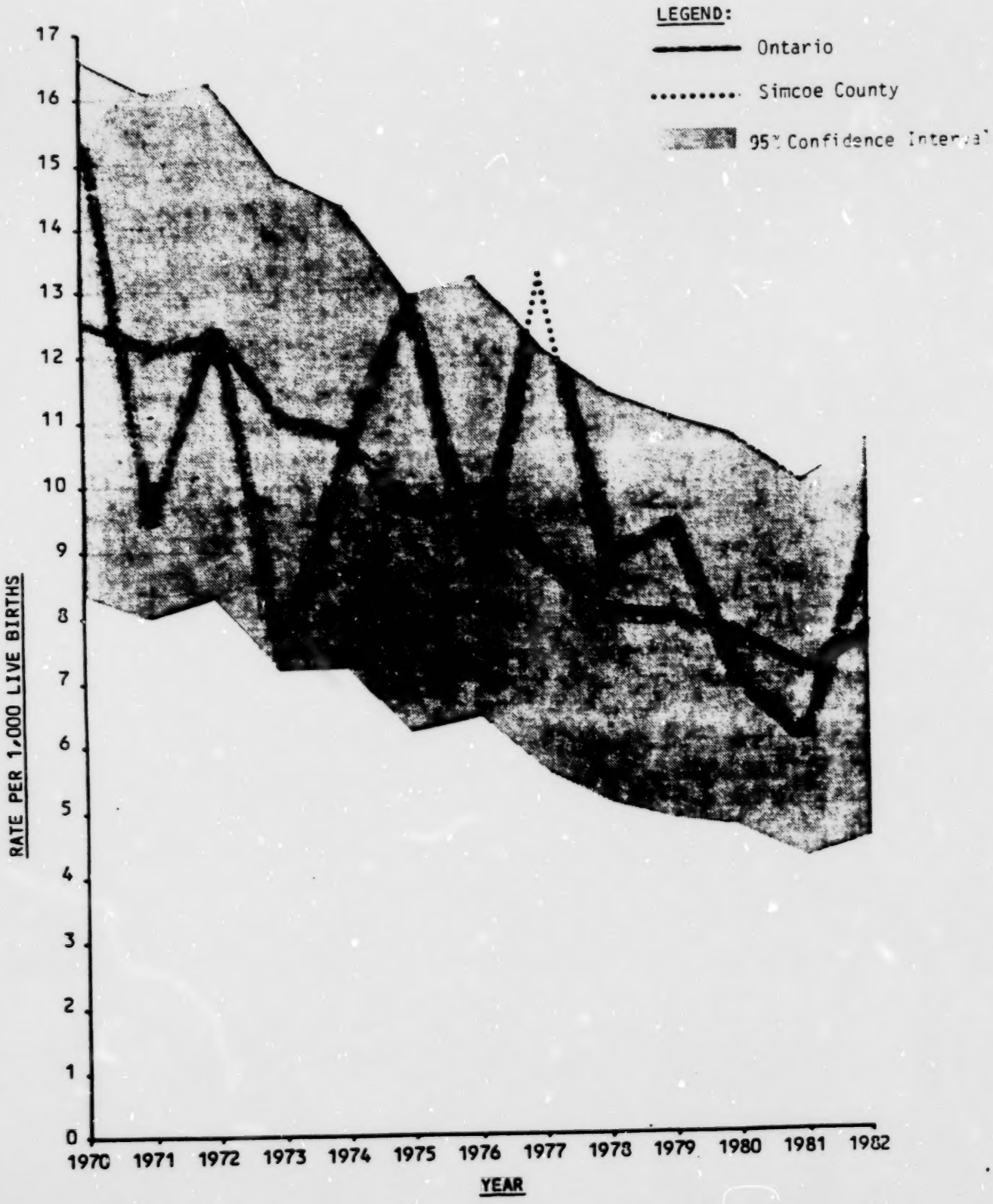
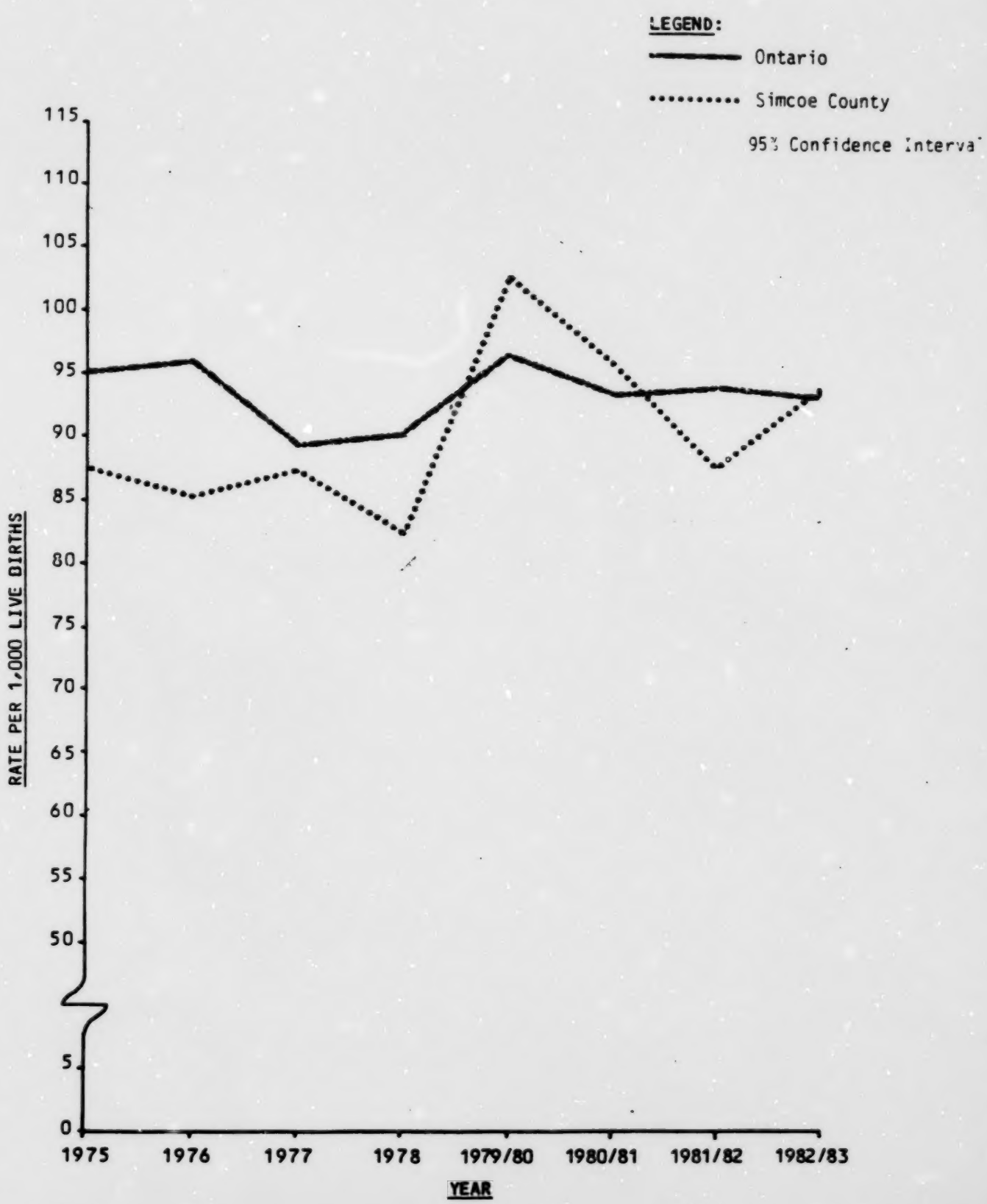


FIGURE 3

SPONTANEOUS ABORTION RATES PER 1,000 LIVE BIRTHS FOR THE PROVINCE OF ONTARIO AND SIMCOE COUNTY 1975-1982



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